

# Food composition of the raccoon dog *Nyctereutes procyonoides* Gray, 1834 in Finland

By P. VIRO and H. MIKKOLA

Department of Zoology, University of Oulu and Department of Zoology, University of Kuopio

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## Abstract

Studied the diet of the raccoon dog *Nyctereutes procyonoides* Gray, 1834 in central and south-eastern part of Finland in 1957–1978.

The composition of the diet, based on macroscopic examination of 45 stomachs, is presented both in frequencies of occurrence and in absolute numbers of different food items. The food mainly consisted of small mammals (in 64.3% of the stomachs), plants (60.7%) and amphibians (50.0%) during the snowless period of the year. In winter carcasses (92.9%), small mammals (50.0%) and plants (42.9%) were the most important.

In Finland, the north-western corner of its present distribution area, the raccoon dog has adapted considerably to living on slaughtering wastes and carcasses especially during the winter. Competition for food between the raccoon dog and the badger (*Meles meles*) is eased by the omnivorous character of both species and by dietary differences.

## Introduction

The raccoon dog, *Nyctereutes procyonoides* Gray, 1834, originated in eastern Asia, was introduced to the European part of the U.S.S.R. in 1934 (HEPTNER et al. 1974), after which the subspecies *N. p. ussuriensis* Matschie, 1907 has spread into Finland and other European countries (NOWAK and PIELOWSKI 1964; SIIVONEN 1972; HEPTNER et al. 1974). The raccoon dog occurs commonly nowadays in central and south-eastern parts of Finland (SIIVONEN 1977), over 1000 km north of its original habitats. In order to survive under these conditions it has to find enough food during the autumn before the long winter sleep, and if it wakes up in the middle of this resting period, food must be easily available, as the preying success of the species is obviously very low in winter (see HEPTNER et al. 1974).

The diet of the raccoon dog has been well documented in the European parts of the U.S.S.R. (e.g. MOROZOV 1948, 1953; RUKOVSKIJ 1950; KORNEEV 1954; SOROKIN 1956; HELLER 1959; PRUSAITE 1960; KRITSKA'A 1961; SAMUSENKO and GOLODUŠKO 1961; IVANOVA 1962; NAABER 1971), in the delta area of the River Danube (BARBU 1972), and also recently in Japan, where the subspecies *N. p. viverrinus* Temminck, 1844 forms part of the original fauna (YAMAGUCHI 1976; IKEDA et al. 1979).

The aim of the present study is to describe the diet of the raccoon dog in Finland, in the extreme conditions prevailing on the north-western edge of its vast distribution area. Specific reference is also made to dietary overlapping with the badger, *Meles meles*.

## Material and methods

Between 1957 and 1978 the Zoological Museum at the University of Oulu, the Natural History Department of Kuopio Museum and the taxidermist PENTTI ALAJA of Vesanto, Finland, have collected 45 raccoon dogs from south-eastern and central Finland (Fig. 1).

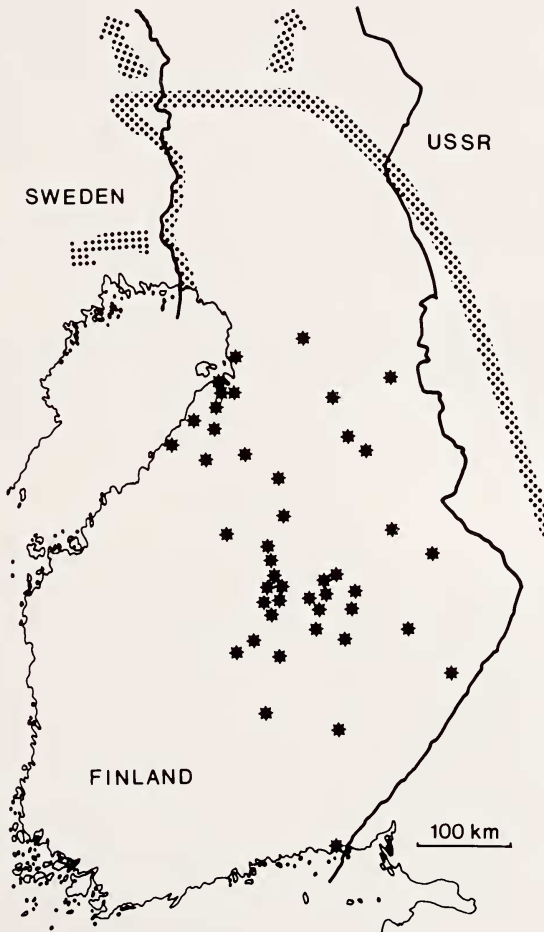


Fig. 1. Distribution of the raccoon dog in Finland (SIIVONEN 1977) and trapping sites of the specimens studied

Of the 42 stomachs containing food remains, 14 originated from the winter period (November, March–April) and the rest from the snowless period of the year (June–October). The number of prey specimens was calculated whenever possible. It was often difficult to decide which specimens had been killed by the raccoon dog and which had been found as carcasses. The occurrence of *Calliphoridae* larvae was used as a sign of carcasses, as also was the size of the food items. Pieces of plastic, paper or aluminium indicated that the raccoon dog had utilized a rubbish dump as its source of food (frequency 28.6% in the snowless period and 35.7% in the winter time).

Only abundant remains of plants, berries and seeds were regarded as real food items, small pieces of grass, needles, etc. having most likely been taken accidentally along with the food items proper.

## Results

### Food composition during the snowless period

During the snowless period (VI–X) the raccoon dog in Finland has very varied diet (Table 1), small mammals forming the main food items (64.3%) and plant material the second most important group (60.7%). Berries of the following species were listed: bilberry (*Vaccinium myrtillus*), red whortleberry (*Vaccinium vitis-idaea*), cranberry (*Vaccinium oxycoccus*), raspberry (*Rubus idaeus*), rowanberry (*Sorbus aucuparia*) and strawberry (*Fragaria* sp.). All the seeds eaten were oat grains (*Avena* sp.). The stomachs contained remnants of four toads (*Bufo bufo*) and 24 frogs (*Rana* sp.).

35.7% of the stomachs contained carcasses and plant remnants which had most likely been taken from the rubbish dumps. This category included pork, hen remnants, sausage skin, apple peel, boiled potatoes, etc.

Six stomachs contained Calliphoridae larvae, which had been consumed together with some animal remains. The adult invertebrates eaten were mostly insects (e. g. Hymenoptera,

Table 1

Occurrence of the main food items in the stomachs of raccoon dog specimens captured in Finland in terms of the numbers of food items (N) and absolute (F) and percentage frequencies of occurrence

Food items	Snowless period (VI - X)			Winter (XI, III - IV)		
	Frequency			Frequency		
	N	F	%	N	F	%
Mammals	71	18	64.3	11	7	50.0
<i>Mus musculus</i>	2	2	7.1	-	-	-
<i>Rattus norvegicus</i>	4	3	10.7	-	-	-
<i>Micromys minutus</i>	8	5	17.9	-	-	-
<i>Microtus agrestis</i>	26	7	25.0	-	-	-
<i>Ondatra zibethica</i>	2	2	7.1	-	-	-
<i>Arvicola terrestris</i>	4	2	7.1	-	-	-
<i>Clethrionomys glareolus</i>	1	1	3.6	6	2	14.3
<i>Sorex</i> sp.	21	9	32.1	3	3	21.4
Birds	11	10	35.7	3	3	21.4
Reptiles	2	2	7.1	-	-	-
Amphibians	28	14	50.0	-	-	-
Fish	7	4	14.3	-	-	-
Invertebrates		13	46.4		2	14.3
Carabidae	6	3	10.7	-	-	-
Calliphoridae larvae		6	21.4		1	7.1
Carcasses		9	32.1		13	92.9
Plants		17	60.7		6	42.9
Berries		10	35.7		2	14.3
Grains		7	25.0		4	28.6
Plant remnants		2	7.1		4	28.6
Number of stomachs		28			14	

Coleoptera, Diptera, Hemiptera, Orthoptera, Odonata), but two spiders (Arachnida) and two earthworms (Lumbricidae) were also found. Invertebrates are obviously only rarely taken as the real prey, however (e.g. Carabidae, Dytiscidae), and most of them could have been eaten accidentally with some other food.

Eleven birds were found: one teal (*Anas crecca*), one redbreasted merganser (*Mergus serrator*), one woodcock (*Scolopax rusticola*), one hazelhen (*Tetrastes bonasia*), one black-headed gull (*Larus ridibundus*), one hooded crow (*Corvus cornix*), one redpoll (*Carduelis flammea*) and four unidentified specimens.

Fish and reptiles seem to be taken only very occasionally. Five perch (*Perca fluviatilis*), two Cypriniformes species, one viper (*Vipera berus*) and one common lizard (*Lacerta vivipara*) were observed in this material.

### Food composition during the winter

13 out of the 14 raccoon dogs killed in winter had eaten mainly carcasses and plant remnants, which they had most likely found on rubbish dumps (Table 1).

Only half of the stomachs contained small mammals, and plants (mostly oat grains) and birds (one jay, *Garrulus glandarius*, one jackdaw, *Corvus monedula* and an unidentified bird) formed much smaller proportions of the diet than during the snowless period (Table 1).

Amphibians and reptiles are not available for the raccoon dog in Finland during the winter, and the fish remnants were thought to have been found as carcasses. The only invertebrates, Calliphoridae larvae, had most likely been eaten along with some other food items.

### Discussion

The raccoon dog is known to be in a low systematic position among the Canidae, which makes it adjustable to new conditions (HEPTNER et al. 1974). Its anatomical properties (weak canine and first molar teeth and a long intestine) make it possible to live on a versatile diet.

In both the U.S.S.R. and Romania the raccoon dog is found to utilize carcasses to a much smaller extent than in Finland (Table 2). In other respects, the present results seem to be most comparable with those from Estonia (NAABER 1971) and the Novgorod-Leningrad area (MOROZOV 1948). The importance of carcasses in the Finnish diet indicates that the raccoon dog has difficulties in searching for food, especially if it wakes up during the winter.

Marked differences are found in the diet, depending on the location and the habitat (NAABER 1971). In its original distribution area in Japan excrement analyses by IKEDA et al. (1979) have shown that insects and plants form the main food throughout the year, the proportion of small mammals being very small, although large amounts of fish and crabs were eaten instead, obviously because of the near-by sea shore. Great seasonal fluctuations in the diet have also been demonstrated earlier (HELLER 1959; BARBU 1972).

It has been shown that the raccoon dog can locally be highly destructive towards game populations, and it is known to cause losses in vegetable gardens, vineyards and cornfields (HEPTNER et al. 1974). The present material included only four game-bird specimens: one teal, one red-breasted merganser, one woodcock and one hazelhen. In addition, there were some feathers and a leg of a mallard (*Anas platyrhynchos*), which was nevertheless thought to have been found as a carcass. According to HEPTNER et al. (1974) the raccoon dog should not be very skillful in killing adult healthy birds, and thus it may well be thought to have taken only injured or sick specimens. On the other hand, we had no material for May, when it might catch some brooding females of game-birds, or at least their eggs or young. This question therefore remains open until further studies can be made covering the whole year.

Oats and strawberries were the only cultivated plants eaten by the raccoon dog in the Finnish material. Obviously the grains of oats are quite an important food item during the au-

Table 2

The diet of the raccoon dog, in occurrence percentages, in Finland, the European parts of the U.S.S.R. and Romania

	Finland (present study)	Estonia (NAABER 1971)	Novgorod-Leningrad (MOROZOV 1948)	Lithuania (PRUSAITE 1960)	Kalinin (SOROKIN 1956)	Byelorussia (SAMUSENKO and GOLODUSKO 1961)	Voronezh (IVANOVA 1962)	Ukraine (KORNEEW 1954)	Manych-steppe (KRITSKA-A 1961)	Astrakhan (RUKOVSKIJ 1950)	Danube delta in Romania (BARBU 1972)
Animal food											
Rodents	40.5	45.0 <sup>+</sup>	52.7	41.3	50.8	80.9	60.4	48.2	42.2	30.2	25.6
Insectivores	31.0	?	0.9	18.8	3.6	-	13.2	1.2	2.9	-	4.8
Birds	31.0	16.0	4.3	15.0	9.2	10.4	23.0	16.9	18.0	16.9	18.4
Eggs	-	5.0	-	-	-	-	-	-	-	-	5.6
Reptiles	4.8	3.7	2.4	3.0	1.0	6.9	3.5	21.4	3.2	35.8	12.0
Amphibians	33.3	12.4	9.5	35.3	19.9	7.1	17.5	37.0	8.4	10.3	34.4
Fish	9.5	-	0.4	0.7	1.4	1.6	-	7.8	8.1	15.0	3.2
Insects	35.7	19.3	29.8	54.1	20.9	50.7	46.5	66.8	57.1	93.4	34.4
Leeches	-	-	-	-	-	-	-	-	-	-	5.6
Earthworms	4.8	-	-	-	-	-	-	-	-	-	-
Molluscs	-	-	-	3.0	0.5	1.5	0.6	7.4	-	3.7	0.8
Carcasses	52.4	-	2.6	-	5.7	-	3.8	0.8	-	-	3.2
Plants	54.8	54.7	94.7	27.7	24.7	42.5	44.2	53.5	?	44.3	37.6
Number of stomachs	42	917	1066	133	578	505	636	500	238	106	?

<sup>+</sup> 45.0 % includes all small mammals

tumn (25.0%) and winter period (28.6%), although it is difficult to believe that the amount of oats taken by this species could be of any economic importance. HELLER (1959) similarly shows that oat grains form the main part of the plant food during the autumn.

The raccoon dog has similar ecological requirements in Finland as does the badger (see NYHOLM 1972), stomach contents from which have been studied in Finland by KILJUNEN (1973). Comparison of the food composition showed a great overlap, although some differences also emerged:

Food items	Occurrence frequencies (%) in April-September		$\chi^2$	p
	Badger (KILJUNEN 1973)	Raccoon dog (present study)		
Plants	18	70	13.444	<0.001
Amphibians	13	43	5.633	<0.025
Carcasses and plant remnants	8	35	4.905	<0.050
Number of stomachs	24	23		

The invertebrates are the preferred food items of the badger (KILJUNEN 1973), though their frequency of occurrence does not differ significantly from that found in the raccoon dog. In southern and central Sweden, for example, SKOOG (1970) listed the preferred food items of the badger as being earthworms, insects, plants and small mammals. Both the raccoon dog and the badger are omnivorous species, and this obviously helps them to live in close proximity even though their food preferences overlap. According to HEPTNER et al. (1974) both species prefer to the same type of den, and competition for these may well be heavier than for food.

In conclusion, our results suggest that the raccoon dog has succeeded in changing its food habits when living in Finland, some distance from its original distribution area. It feeds on cultivated plants only in small quantities and it cannot be considered harmful to game animals on the evidence of the present material. No real competition with the badger for food can be thought to exist, since both species have a very versatile diet.

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#### Zusammenfassung

##### *Die Zusammensetzung der Nahrung des Marderhundes Nyctereutes procyonoides Gray, 1834 in Finnland*

Die Nahrung des Marderhundes *Nyctereutes procyonoides* Gray, 1834 wurde in Mittel- und Südostfinnland in den Jahren 1957–1978 untersucht. Der Inhalt der Mägen von 45 erbeuteten Marderhunden wurde makroskopisch analysiert. Die Zusammensetzung der Nahrung wird sowohl nach Häufigkeit des Vorkommens als auch nach Anzahl der verschiedenen Nahrungsobjekte dargestellt.

Während der schneefreien Zeit besteht die Nahrung des Marderhundes hauptsächlich aus kleinen Säugetieren (in 64,3% der Mägen), Pflanzen (60,7%) und Amphibien (50,0%). Im Winter waren Aas (92,9%), kleine Säugetiere (50,0%) und Pflanzen (42,9%) die wichtigsten Nahrungsobjekte.

In Finnland, in der nordwestlichen Region seines heutigen Verbreitungsgebietes, hat der Marderhund deutlich seine Fressgewohnheiten ändern können. Besonders wenn Schnee liegt (bei Unterbrechungen der Winterruhe) bilden Schlachtreste und Aas einen beträchtlichen Teil seiner Nahrung. Die Konkurrenz zwischen Marderhund und Dachs (*Meles meles*) wird durch die Tatsache, daß beide Arten Allesfresser sind, und durch die unterschiedliche Bevorzugung der Nahrungsobjekte gemildert.

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Authors' addresses: PIRKKO VIRO, Department of Zoology, University of Oulu, SF-90100 Oulu 10;  
HEIMO MIKKOLA, Department of Zoology, University of Kuopio, P. O. B. 138,  
SF-70101 Kuopio 10

## Sebaceous glands of the anal sacs of *Genetta tigrina* (Schreber, 1778)

By F. I. B. KAYANJA and H. SCHLIEMANN

Department of Veterinary Anatomy and Histology, Makerere University, Kampala,  
Zoologisches Institut und Zoologisches Museum, Universität Hamburg

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### Abstract

Studied the sebaceous glands of the anal sac wall of *Genetta tigrina* by means of light and electron microscopy. The anal sac wall of *Genetta* contains two elaborate complexes of sebaceous glands. The glandular epithelium consists of peripheral cells lying against the basal lamina, intermediate and mature cells. The intermediate cells are the most active cells according to their ultrastructure. The cytoplasm contains mitochondria with a mixture of tubuli and cristae, filaments, lipid droplets, elaborate smooth endoplasmic reticulum, and rigidly patterned crystalloids. The latter are associated with the granular endoplasmic reticulum. The ultrastructure of these cells suggests a steroidogenic role.